

P-6.1 Summarize the production of sound and its speed and transmission through various media.

Revised Taxonomy Level 2.4 Summarize conceptual knowledge

In Physical Science students

- ❖ Understand that sound waves are longitudinal mechanical waves
- ❖ Understand how the particles of the medium are disturbed in a longitudinal wave
- ❖ “Summarize reflection and interference of sound waves.

It is essential for all students to

- ❖ Describe the behavior of waves in various media
- ❖ Analyze the behavior of waves at boundaries between media (propagation, refraction, inverted and erect reflection)
- ❖ Compare constructive and destructive interference
- ❖ Analyze the relationship between the phenomena of interference and the principle of superposition.
- ❖ Explain how a standing wave is formed
- ❖ Explained how forced vibrations or oscillations can produce resonance
- ❖ Explain the variations of the speed of sound in different media.

Assessment

The revised taxonomy verb summarize means “to abstract a general theme or major point” For this indicator, the major focus of assessment should be to insure that students have a deep conceptual understanding of the production and transmission of sound waves based on principals of waved transmission and propagation. Conceptual knowledge requires that students understand the interrelationships among the basic elements within a larger structure that enable them to function together. In this case, that students understand the effect that each wave property has on sound transmission and propagation.

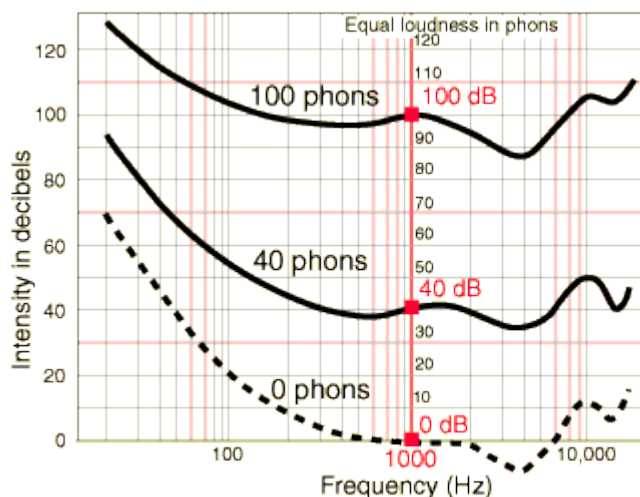
P-6.2 Explain how frequency and intensity affect the parts of the sonic spectrum.

Revised Taxonomy Levels 2.7 B Explain conceptual knowledge

Physical science students did not address this concept

It is essential for all students to

- The range of audibility of the human ear depends upon the relative intensity of a sound in conjunction with the frequency of the sound.
- Relative intensity measurements (decibels)
 - ◆ Compare the intensity of a particular sound to the intensity of a sound at the threshold of hearing (I_0)
 - ◆ The relative intensity of sound is a logarithmic scale
 - ◆ Relative intensity (measured in bels) = $\log I/I_0$
 - ◆ Ten bels = one decibel = $10 \log I/I_0$



Example
equal - loudness
curves for the
human ear.

a phon is a unit of subjective measure of loudness level. The level in phons is equal in number to the sound intensity of a 1,000-hertz reference sound, measured in decibels, judged to be the same loudness as the measured sound.

Assessment

The verb explain means that the major focus of assessment should be for students to “construct a cause and effect model”. In this case, assessments will ensure that students can model how the combination of relative intensity and frequency affect the human perception of sound. Because the indicator is written as conceptual knowledge, assessments should require that students understand the “interrelationships among the basic elements within a larger structure that enable them to function together.” In this case, assessments must show that students can construct a cause and effect statement relating how the relative intensity of a sound and the frequency affect the human perception of sound.

P-6.3 Explain pitch, loudness, and tonal quality in terms of wave characteristics that determine what is heard

Revised Taxonomy Levels 2.7 B Explain conceptual knowledge

In third grade, students

- ❖ Compare the pitch and volume of different sounds (3-5.6)
- ❖ Recognize the ways to change the volume of sounds (3-5.7)
- ❖ Explain how the vibration of an object affects pitch (3-5.8)

In physical science students

- ❖ Understand that changes in sound frequency as are perceived as changes in the pitch of the sound.

It is essential for students to

- ❖ Understand the qualitative and quantitative relationship between the intensity of a sound and the amplitude of the wave
- ❖ Understand the qualitative and quantitative relationship between the pitch of a sound and the frequency of the wave.
- ❖ Understand how tonal quality of a sound is determined by the frequency ratio of the waves comprising it

Assessment

The verb explain means that the major focus of assessment should be for students to “construct a cause and effect model”. In this case, assessments will ensure that students can model how the wave characteristics of frequency and amplitude affect the perception of sound and how the ratio of the frequencies of several sounds determine the quality of a sound. Because the indicator is written as conceptual knowledge, assessments should require that students understand the “interrelationships among the basic elements within a larger structure that enable them to function together.” In this case, assessments must show that students can construct a cause and effect statement relating how the frequency and amplitude of sound waves affect the human perception of sound.

P-6.4 Compare intensity and loudness

Revised Taxonomy Level 2.6 Compare conceptual knowledge

This concept was not addressed in physical science

It is essential for students to

- ❖ Understand that the loudness of a sound is a subjective term which depends upon the intensity of the sound source, the frequency of the sound, the distance from the sound, and the acuity of the listener
- ❖ Understand that the intensity of a sound is an objective measurement
 - Dependent upon the power of the source and the area that the sound has covered
 - $I = P/A$ where I is sound intensity, P is sound power in watts and A is the square area in meters
 - Intensity is measured in units of watts per square meter
- ❖ Solve problems involving the intensity of various sounds

Assessment

As stated in the indicator, the major focus of assessment is to compare (detect correspondences) in the terms loudness and intensity and in the ways that they are measured and used. Because the indicator is written as conceptual knowledge, assessments should require that students understand the “interrelationships among the basic elements within a larger structure that enable them to function together.” In this case, assessments must show that students understand the reasons for the difference in the way that the variables are measured in the two types of circuits based on their knowledge of current flow in the two circuits.

P-6.5 Apply formulas to determine the relative intensity of sound

Revised Taxonomy Level 3.2 C_A Apply (implement) procedural knowledge

It is essential for all students to

Understand relative intensity measurements (decibels)

- ❖ Compare the intensity of a particular sound to the intensity of a sound at the threshold of hearing (I_0)
- ❖ Understand that the intensity of sound at the threshold of hearing is 10^{-12}W/m^2
- ❖ The relative intensity of sound is a logarithmic scale
- ❖ Relative intensity (measured in bels) = $\log I/I_0$
- ❖ ten bels = one decibel = $10 \log I/I_0$.
- ❖ solve problems involving the relative intensity of sound

Assessment

As the verb for this indicator is implement (apply), the major focus of assessment will be for students to show that they can “apply a procedure to an unfamiliar task”. The knowledge dimension of the indicator is “knowledge of subject-specific techniques and methods” In this case the procedure is the application of the formula for the relative intensity of sound. The unfamiliar task should be a novel word problem or laboratory investigation. A key part of the assessment will be for students to show that they can apply the knowledge to a new situation, not just repeat problems which are familiar. This requires that students have a conceptual understanding of the relative intensity of sound as well as mastery of the skills required to implement the mathematical equation or in order to solve the problem.

P-6.6 Apply formulas in order to solve for resonant wavelengths in problems involving open and closed tubes.

Revised Taxonomy Level 3.2 C_A Apply (implement) procedural knowledge

In physical science students

- ❖ Understand that sound waves reflect in tubes or some musical instruments to produce standing waves which reinforce sound through constructive interference.

It is essential for students to

- ❖ Understand the concept of forced vibrations
- ❖ Understand the concept of resonance
- ❖ Understand that a resonant air column can be produced in open or closed tubes.
- ❖ Understand the conditions that are necessary for a column of air to be resonant in a specific tube
- ❖ Understand and apply the equations for finding the wavelength of a wave that is resonant in a specific tube
 - Closed tube $\lambda = 4(l + 0.4d)$
 - Open tube $\lambda = 2(l + 0.8d)$

Assessment

As the verb for this indicator is implement (apply), the major focus of assessment will be for students to show that they can “apply a procedure to an unfamiliar task”. The knowledge dimension of the indicator is “knowledge of subject-specific techniques and methods” In this case the procedure is the application of the formula for wavelength of a resonant wave within a tube.. The unfamiliar task should be a novel word problem or laboratory investigation. A key part of the assessment will be for students to show that they can apply the knowledge to a new situation, not just repeat problems which are familiar. This requires that students have a conceptual understanding of the process of resonance as well as mastery of the skills required to implement the mathematical equation or in order to solve the problem.

P-6.7 Explain the relationship among frequency, fundamental tones, and harmonics in producing music

Revised Taxonomy Levels 2.7 B Explain conceptual knowledge

Physical science students did not address this indicator

It is essential for students to

- ❖ Understand the concept of fundamental tones and harmonics.
- ❖ Understand the relationship between the frequency of sounds that are one octave apart.
- ❖ Understand that the quality of a sound depends upon the number of harmonics produced and their relative intensities.

Assessment

The verb explain means that the major focus of assessment should be for students to “construct a cause and effect model”. In this case, assessments will ensure that students can model how the frequency of the tones produced affect the perception of sound and how the ratio of the frequencies of several sounds determine the quality of a sound. Because the indicator is written as conceptual knowledge, assessments should require that students understand the “interrelationships among the basic elements within a larger structure that enable them to function together.” In this case, assessments must show that students can construct a cause and effect statement relating how the frequency and of sound waves affect the human perception of sound and its quality.

P-6.8 Explain how musical instruments produce resonance and standing waves.

Revised Taxonomy Levels 2.7 B Explain conceptual knowledge

Physical science students did not address this indicator

It is essential for students to

- ❖ Understand how various types of musical instruments produce sounds that vary in frequency and quality.
 - Strings
 - Woodwinds
 - Percussion
 - Brass
- ❖ Understand the ways that various instruments get “out of tune” and how the concept of “beats” can be used to tune an instrument

Assessment

The verb explain means that the major focus of assessment should be for students to “construct a cause and effect model”. In this case, assessments will ensure that students can model how familiar instruments produce sounds of various frequency and amplitude. Because the indicator is written as conceptual knowledge, assessments should require that students understand the “interrelationships among the basic elements within a larger structure that enable them to function together.” In this case, assessments must show that students can construct a cause and effect statement relating each class of instrument is manipulated to produce various frequencies and amplitudes of sound.